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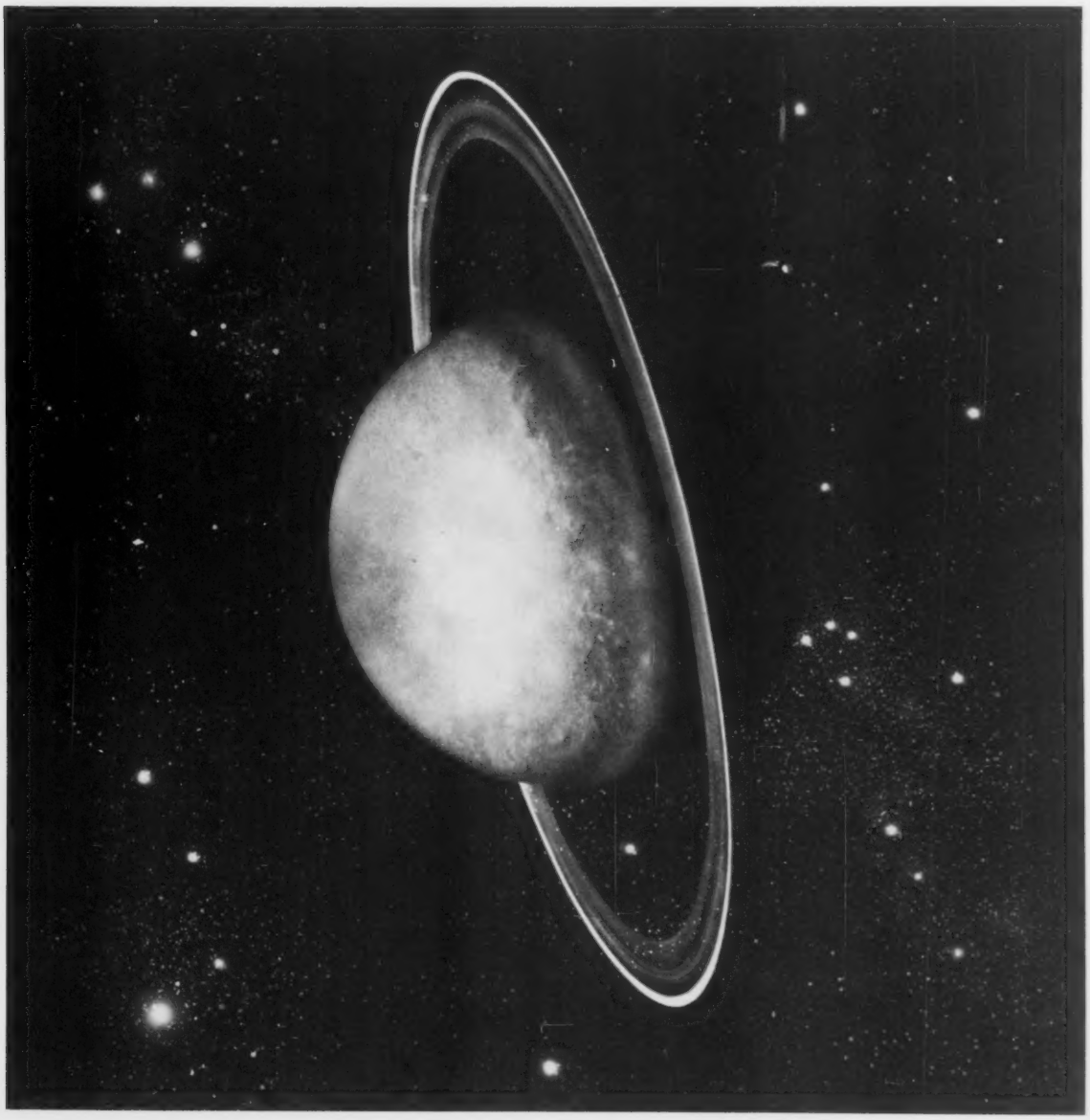

Cover

New Space Phenomenon Discovered from NASA Observatory—A startling feature of the planet Uranus (seventh planet out from the Sun, almost 1.6 billion kilometers (a billion miles) beyond Saturn) is that at least five rings encircle the planet in a narrow belt measuring about 7,000 km. wide. A detailed decription of the rings was given by their discoverer, Dr. James Elliott of Cornell University, assisted by graduate student Edward Dunham and computer programmer Douglas Mink, at a recent Ames Research Center press conference. Elliott named the rings alpha, beta, gamma, delta and epsilon, from the Greek alphabet. The discovery of the never-before-observed rings (it was previously thought that Saturn was unique in that respect) was made from the Ames center's Kuiper observatory, a greatly modified C-141 aircraft. This artist's concept of the rings, by Rick Sternbach, was produced in collaboration with Elliott, their discoverer.

Correction—The editor was sound asleep at the the switch concerning the facts quoted in the first line of "Investigators Chosen for First Spacelab Flight," on page 8 of the April issue. As one NASA wag put it: "It's gonna be pretty crowded up there," (referring to the 222 scientists the article claimed would be aboard the first Spacelab flight). The sentence should have read: "222 scientists have been selected to participate in the first Spacelab flight in 1980."

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Letter from Washington

Dear Colleagues:

Since March 10, the day that Jim Fletcher announced his resignation, there has been a steady flow of telephone calls, telegrams and letters expressing appreciation to him for his period of distinguished service to government and wishing him well.

These warm messages have come from all walks of life—from industrialists, educators, officers of the armed forces and civilian leaders in the DOD, journalists, Jim's colleagues in a dozen departments of government and some from citizens with no direct connection other than a deep interest in the space program. Among the letters he cherishes the most are ones from NASA employees here in headquarters and at the field centers. These communications reflect, of course, the high professional esteem and affection in which Jim Fletcher is held by all.

Jim came to NASA in April of 1971. No one knows better than NASA employees the level of activity in the past six years. Think how much has happened since he was sworn in as Administrator.

- The last three Apollo missions were flown and this dramatic program was successfully concluded.
- Three Skylab missions and Apollo Soyuz added a total of six months of manned operations in space. And ASTP demonstrated to all the world the viability of major cooperative human endeavors in space.
- Mariner 9 sent back the first pictures of Martian volcanoes, dust storms and ancient stream beds.
- Pioneers 10 and 11 gave us our first close-up looks at Jupiter, and will be the first man-made objects to leave the solar system.
- We have flown by Venus and Mercury with Mariner 10.
- Two spacecraft have made soft landings on Mars and two more are orbiting Mars.
- We are preparing to launch two spacecraft this summer to fly by Jupiter and Saturn and, if all goes well, one of them will proceed on to Uranus and Neptune.
- Landsat has opened our eyes to the resources we possess and, in turn, has made it possible for us to improve the management of the nation's resources.
- And we have seen the Shuttle Orbiter take to the air on the back of a 747. In 1980 men and women alike will be working routinely in space over extended periods of time, and this same Shuttle will be delivering materials and people regularly to and from space.
- HEAO-A opens a new era of astrophysics.

Jim has also left a rich legacy for his successor.

The space telescope will become the first permanent astronomical observatory in space and will undoubtedly dominate astronomical research in the remaining decades of this century.

The Jupiter Orbiter and Probe assure us a continuing exciting planetary exploration program in the 1980s.

Spacelab will almost literally enable space scientists to move their laboratories into space.

An aircraft energy efficiency program has been started, focused on improvements in engine performance and aircraft design, its goal being a 50 percent reduction in fuel requirements.

To further improve aircraft performance, a program has been instituted to revitalize the nation's aeronautical test facilities. The major NASA elements are the unique National Transonic Facility at Langley and a major addition to the 40 x 80 foot wind tunnel at Ames to accommodate advanced VTOL aircraft and Rotorcraft.

As Administrator, Jim Fletcher pursued with a dedicated vigor and enthusiasm NASA's heritage of a continuing quest for excellence within the framework of his two underlying personal goals—a convincing technological superiority for the United States among the nations of the world, and international cooperation in space as the most effective path to lasting peace for our planet. He believed very strongly in the national importance of a vigorous and growing effort in space. This was equally true of aeronautics.

His outlook on aeronautics is best expressed in his own words:

"Aviation" he said, some time ago, "is vital to our economy and our defense posture, and the United States must retain the ability to pace such development to the maximum national advantage. To do so, it must possess an adequate fund of high-quality, modern technology—which NASA has the obligation, and the capability, to provide."

Jim has strong beliefs. They are sound beliefs. As NASA Administrator he acted on them, and, because of this, I believe NASA and this nation are better off today.

Sincerely,

A. M. Lovelace

Alan M. Lovelace

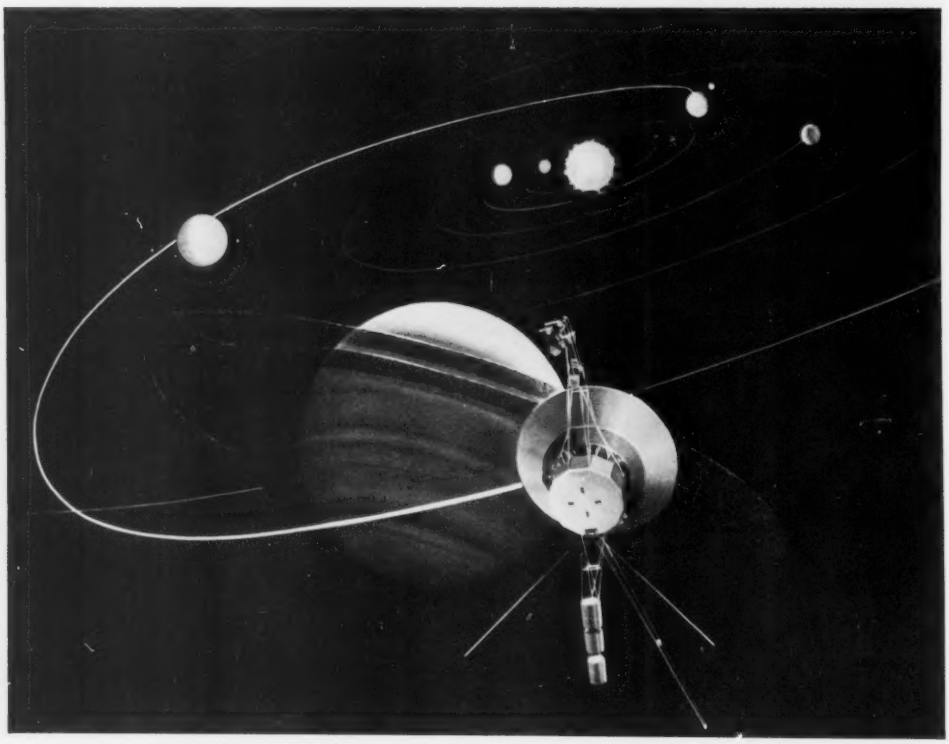
Monthly NASA Highlights

New Name for Interplanetary Missions

Two spacecraft scheduled for launch this summer to undertake extensive reconnaisance of Jupiter, Saturn and perhaps Uranus and Neptune have been designated as Voyager 1 and Voyager 2. The name Voyager was chosen from among scores of names submitted by scientists and engineers associated with the project, and by members of the nation's science press corps.

The Voyagers are scheduled to be launched from NASA's Kennedy Space Center on Aug. and Sept. 1 on trajectories that will take them to giant Jupiter and ringed Saturn and also past several moons of both planets. If all goes well, one of the Voyagers then will be targeted for the first encounter with Uranus, some 2.7 billion kilometers (1.7 billion miles) from Earth, and possibly Neptune 4.3 billion km (2.7 billion mi.) distant.

Voyager Mission—How an artist sees the first of two spacecraft to be launched from the Kennedy Space Center this coming August as it passes near Saturn. The dual Titan/Centaur launch operation is almost a replay of the back-to-back Mars Viking launches that took place in 1976. Kennedy's expendable vehicles directorate is now processing flight hardware.



The Voyagers were designed and are being built at NASA's Jet Propulsion Laboratory. Each of the 800-kilogram (1,750-pound) spacecraft will carry wide-angle television cameras and 10 scientific instruments.

The first Voyager will encounter Jupiter in March 1979, passing within 357,000 km (222,000 mi.) of the planet. Its cameras will take man's first close-up pictures of Jupiter's four largest moons.

The craft will arrive at Saturn in November 1980, flying past at a distance of 209,000 km (130,000 mi.), and within 6,430 km (4,000 mi.) of Titan, Saturn's largest moon. Closeup observation of Saturn's rings and of Titan—the only known planetary moon to have an atmosphere—also will be a first.

NASA already has sent spacecraft to Venus, Mercury, Jupiter and Mars. Project Voyager is the next step in the United States program of systematic planetary exploration, in which the solar system is used as a natural laboratory. By being able to compare the similaries and differences of the various planets, scientists hope to learn more about the history and future of the solar system and particularly our own planet Earth.

Eighth Lunar Science Conference

The eighth annual Lunar Science Conference was held at NASA's Johnson Space Center during the week of March 14 to 18. More than 600 scientists from the United States and abroad attended this year's annual conference. The first conference was held in 1970 when scientists gathered to hear the scientific results from the first manned lunar mission, Apollo 11.

The conference was highlighted by the presentation by Soviet scientists to the United States of two-and-a-half grams of lunar soil collected and returned by the Soviet Luna 24 spacecraft last August. In addition to lunar science presentations, topics in planetary sciences and results of the Viking spacecraft were included in conference discussions.

Scientists attending the conference in such diverse fields as geology, chemistry, physics, astronomy, engineering and biology indicate the growing interest and scope of the conference, which is sponsored jointly by the Johnson center and the Lunar Science Institute, Houston. ■■■

A Prelude to Living in Space

NASA is carrying out numerous experiments involving adults in almost all age groups in a continual effort to recreate on Earth the environment to which humanity eventually must adapt in outerspace. Risks and remedies must be determined and evaluated before Earth dwellers can live and work outside the confines of their atmosphere. This is the first of a two-part article which describes a NASA medical program.

On the morning of April 14, 10 women in the 35 to 45 age group voluntarily signed in at the Human Reseach Facility Center to begin a 27-day schedule of rigorous and demanding medical tests. The primary objective of the tests is not to assess the state of an individual's health. It is to study tolerance differences of various age groups to the stressful effects on the human anatomy when Space Shuttle passengers re-enter Earth's atmosphere after several days of weightlessness in space.

The medical research program, which bears the title "Shuttle Re-Entry Acceleration Tolerances in Male and Female Subjects Before and After Bed Rest," is conducted by members of the Biomedical Research Division at the Ames center, under the direction of Harold Sandler, M.D. He will be assisted by Joan Vernikos-Danellis, Ph.D., and Danielle Goldwater, M.D. The facility manager is Dee O'Hara, R.N. (She is well known in space circles as the nurse who took part in all NASA's manned space missions, from the Mercury program to ASTP.)

The rationale for using bed rest to measure bodily responses is that prolonged bed rest is one way by which a physiological approximation of the zero gravity experienced in space can be achieved on Earth. Bodily changes begin within 24 to 48 hours after total bed rest begins and continue to develop throughout the subsequent seven days.

Once zero gravity has been approximated, medical researchers can study human responses to the introduction of both normal and abnormal Shuttle re-entry gravity forces. Other tests assess the value of anti-gravity suits as a protection against the stresses experienced during re-entry.

By the time the program closes, 48 healthy men and women aged 35 to 65 years will have participated in the study, the most extensive of its kind to date. Eight men in the 35 to 45 age group successfully completed their testing in June 1976. In 1973, a group of younger nurses (ages 20 to 35) underwent similar tests at the Ames center. Nobody in either group suffered any serious physical change. Most said that discomfort and boredom were their only adverse reactions. The extent of risk is not known, however, at the 50 to 65

age level, though doctors do know that a loss of consciousness resulting from certain of the tests is more likely in older subjects. Medical managers do not anticipate serious reactions on the part of the older volunteers, but in all cases are completely equipped to deal with all possible emergency situations.

Volunteers for Stress Studies—The ten women selected as participants in the 27-day medical test at the Ames Research Center are: (top row, l. to r.) Rita L. McIntire, electronics technican; Marion Hays, freelance writer-actress; Wendy L. Heyman, drapery manufacturer; Chrisula Asimos, teacher-medical researcher; Christine Smith, homemaker-registered nurse; (bottom row, l. to r.) Charlene D. Johnson, retail sales clerk; Mary C. Gerbino, housewife-freelance writer; Carol Pruit, vocational nurse; Gloria A. Martinez, technician; and Nancy Lou Deardorff, banker.

Why are ordinary people being asked to complete long and arduous experiments and why do they eagerly volunteer for the privilege of becoming subjects in such experiments?

The answer to the first question is related to physical problems stemming from the weightlessness encountered in space missions. Earlier medical findings based on space flights by astronauts on Apollo and Skylab missions suggested that a prolonged lack of gravity brought about distinct (though apparently not dangerous or permanent) changes in blood composition, muscle tone, bone substances and circulatory and heart functions.

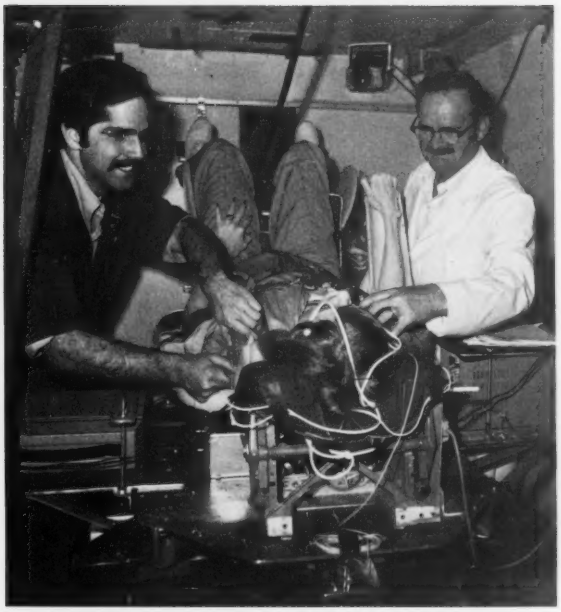
In all cases, the astronauts' finely trained bodies re-adapted quickly to their customary earthbound environment even after living and working in space for as long as 84 days, and no lasting effects seemed evident. But the doctors wondered about the physical changes that might take place when ordinary human beings—that is, people unschooled in methods of combatting the difficulties produced first by a zero gravity ambience, then by abnormally high gravity fields—try to live and work in space. Also needed are evaluations of the human ability to perform prescribed duties efficiently aboard spacecraft while under the pressures of re-entry into Earth's atmosphere.

To the second question, an answer by one of the subjects says it all: "I want to do what I can to help the space program—and I guess this is the closest I'll ever get to participating in space missions."

Almost certainly it *is* the closest the volunteers will come to space travel in the near future. Nor will fame and fortune be their rewards—most will remain anonymous and their pay is at the rate of only $3 to $4 per hour, as required by the Fair Labor Standards Act. The dedication and sincerity of the volunteers are demonstrated by the fact that, to date, not one person has withdrawn (an automatic provision made clear at the beginning of the tests) from any of the projects.

All the experiments are divided in several ways, by sex, by age group and by types of tests administered. For example, eight to 10 men or women in the 35 to 45 age groups are the subjects of two separate three-stage experiments; next comes the 45-to-55-year-old

Cardiovascular System Tests—Nichelle Nichols, with Astronaut Alan Bean, demonstrates how the lower body negative pressure device operates in medical projects designed to help solve problems encountered in space. Volunteers at the Ames Research Center are participating in this and other medical research involving human participation in Space Shuttle voyages.



Tests for Space Travelers—Centrifuge technicians Dan Gundo (left) and Sil Corpuz assist one of the Ames center volunteers to make ready for tests involving her reaction to increased rates of gravity as a centrifuge rotates at ever-increasing rates of speed.

group, also divided as to sex; and finally the 55 to 65 year olds. In all, six 27-day research programs are involved.

Incidentally, the test subjects are not involved in the space program. The group of women currently being tested at Ames represents a variety of professions. They include: an airline stewardess, a biomedical researcher, teachers, a journalist, medical technicians, a public administrator, a registered nurse, a real estate salesperson, graduate students, housewives, and others.

Other women also are being tested for various medical reactions at the Johnson Space Center, Houston, Tex., and at the Marshall Space Flight Center, Huntsville, Ala.

At the start of the Ames program, a preliminary selection is made from among some 200 volunteers. The pre-selected group is given a series of extremely stringent physical and psychological tests daily for a week, takes short orientation rides on the human centrifuge at different speeds and goes through lower body negative pressure tests for evaluation of blood and heart functions. In short, to qualify for the full experiment, subjects must first pass tests demonstrating that their circulatory system functions well, that they have no blood defects and that they have good lung functions. They also must demonstrate their ability to withstand and efficiently operate within centrifuge boundaries ranging from the gravity rates ordinarily experienced on Earth to multiples of gravitational force—at the upper extreme, the force is about equal to that exerted when an aircraft executes extremely sharp banking maneuvers at high speeds.

Subjects also learn to fly a flight simulator in a sitting position and lying down, since during the bed rest study all test procedures are done from a supine position.

At all times, medical personnel keep a sharp eye on actions and reactions. Individuals are permitted to halt the testing any time they choose. Frequently during all test phases, the volunteers are advised of what to expect, the reasons for the various procedures and the philosophy behind the research project.

When the final selection has been made, the first of the three-phase study begins. At that point, eight subjects (two of the 10 selected individuals are in a standby category) move into the 12-bed hospital facility at Ames, to embark upon a nine-day control period, followed by nine days of total bed rest and six days of recovery while in an ambulatory status. From this point on, the tests become more demanding as training courses become more advanced.

(*to be continued*)

Shuttle's External Tank as Space Platform?

The only element of the Space Shuttle designed to be expendable is now envisioned as possibly becoming an important part of a permanent space platform. One of several options being studied at the Marshall center is the possibility that the external fuel tank might go into orbit with the *Enterprise*, then become a separate orbiting vehicle. It could then become the nucleus of a space platform.

James E. Kingsbury, chief of Marshall's science and engineering directorate said that from such a permanent platform "the real business of space utilization can begin."

Kingsbury proposed that some of the liquid oxygen propellant in the external tank be unloaded before launch. The space thus gained would allow for a separate compartment of approximately 57 cubic meters (2,000 cubic feet) that could be equipped on the ground for 90 days of crew habitation in orbit. A Shuttle would carry such a tank into orbit and park it.

A second Shuttle launch would carry into orbit a Skylab airlock module and multiple docking adapter and a solar electric conversion wing, which can be docked and clustered to the waiting platform. The same launch would carry the crew of platform inhabitants and an additional 90-day supply of expendables to support the crew of three for six months. The work of the first crew would include construction of additional crew quarters in the remaining volume of the liquid oxygen propellant tank.

"Employing this concept," Kingsbury said, "studies have shown that a permanent space platform can be placed in a three-to-five year orbit with reboost capability. The platform can be expanded in a number of ways, using additional expended tanks or Spacelab modules, or both."

Such a space platform would provide ample laboratory space to begin at least pilot production of the kinds of products envisioned in the space processing program.

Kingsbury said that the studies are far from complete at this time but that all elements so far investigated appear most promising.

As a target, the studies are directed to an initial launch in calendar years 1983-84.

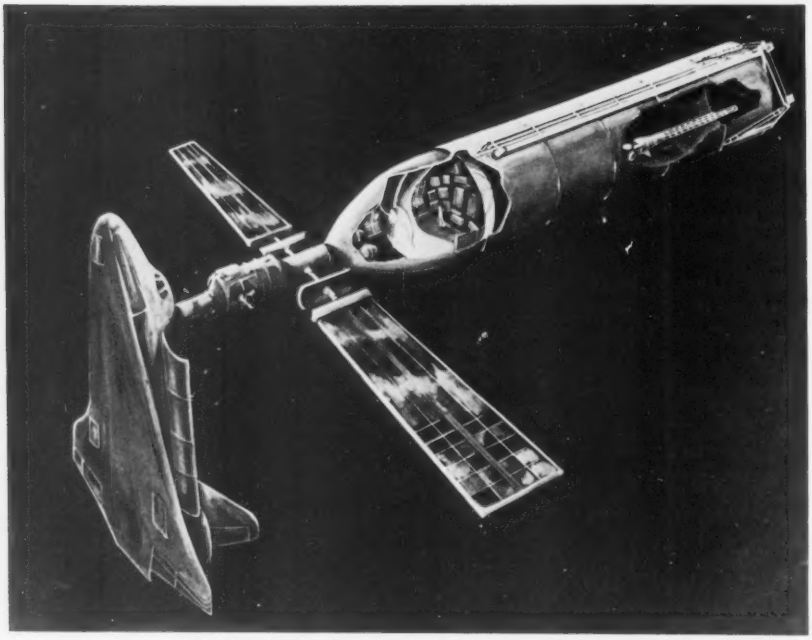
Poem Inspired by Viking Mission

Editor's Note: Activities rarely publishes poetry, but this poem, in commemoration of Viking pictures of Mars struck a responsive note with many NASA people.

To a Martian Sunset

Her sky, arena is for dust.
Her soil blushes sanguine rust.
Magenta world, untouched by man,
But part of God's great cosmic plan.
A veil of darkness taunts this scene,
While wintry blasts vent angry spleen.
As pink shades rose, one looks due west
At glowing sunburst seeking rest.
The swirling dust, stern wind commands,
To web the sky with tinted bands.
Apollo's last great challenge gone,
Grave Mars awaits the coming dawn.
No friendly silhouette remains,
As darkness rides the silent plains.

Stanley B. Demes
Hughes Aircraft Co.,
California



Future Space Platform Proposal—An artist's drawing shows a Marshall center's concept for using the Space Shuttle's external tank in Earth orbit as the first step toward a space platform. A crew of three would inhabit the forward area and construct additional living and working space in the remaining volume (17,500 cubic feet) of the liquid oxygen propellant tank.

Update on Viking

An instrument aboard the Viking-1 lander developed a malfunction in its power supply in mid-March and was turned off. Confirmation of the corrective measure was received in response to commands sent to the spacecraft from NASA's Jet Propulsion Laboratory. Viking project manager G. Calvin Broome explained that an electrical short circuit in an instrument power supply made data generated by the gas chromatograph mass spectrometer unusable.

Before Winter Shutdown—One of the excellent photos the lander was able to send back to Earth shows the red rocks that reach to the horizon nearly two miles from the Utopian Plain on Mars.

The instrument had completed its tests on Martian soil samples some time ago. It established the absence of organic compounds in the surface at a specific Martian location, thus making a fundamental contribution to an understanding of the chemistry of Mars. The instrument also determined the composition of the atmosphere at the planet's surface and discovered the primordial argon isotopes that will help unravel the history of Mars.

In a late March attempt by the Viking-2 lander to acquire a sample for the biology cold incubation run, a no-go was generated by the surface sampler and the operation halted automatically. Apparently the soil sampler elevated and rotated but did not extend. Program managers said the problem very possibly could be related to the extremely low temperatures that existed at the site. As low as they were then, by April temperatures had dropped to even greater lows ranging around —123 C. and below.

The Viking-2 spacecraft, therefore, was ordered into a "survival mode" on April 17. The move, it is hoped, will protect the spacecraft against total loss—a danger under such glacial conditions—until the temperature on Mars rises again in September and October. In the meanwhile, only fragmentary data will be collected and relayed to an orbiter.

Landsat Will Inventory Wildland Resources

Wildland resources in remote areas of Alaska, Arizona and Idaho will be inventoried by Landsat under a cooperative agreement between NASA, the Johnson Space Center and the U.S. Department of the Interior's Bureau of Land Management. The three-part study will provide the BLM with an inventory of major streams, ground cover and vegetation types, drainage patterns, major water bodies, reservoirs and fires, and fire hazards.

The experiment first will concentrate on a portion of south central Alaska due east of Mount McKinley National Park, which contains extensive growths of northern spruce and fir trees in a tundra ecology. The second phase will cover an area in northwestern Arizona representing desert ecology. The final phase of the experiment will cover an area in southwestern Idaho, representing the sagebrush and grassland areas of the Intermountain West.

Each phase of the experiment will last about a year. At the completion of the experiment the partners expect to have developed an automated inventory system providing extensive, timely information about the BLM land.

The experiment is a continuation of NASA's applications program in the Earth resources disciplines. Previous applications which NASA has developed for other agencies or private concerns include a water mapping system and a forest inventory system for the State of Louisiana, which use Landsat information. The applications program plans to transfer the technology gathered during these experiments to all possible public users.

The BLM has broad management authority over 473 million acres of land in 11 western states, and over two-thirds of Alaska.

Important Award for Apollo Soyuz Test Project Astronauts

The White House announced in late March that the 1976 Astronaut's Trophy—one of the highly esteemed Harmon International Aviation Trophies—was awarded jointly to Major General Thomas P. Stafford of the U.S. Air Force and Colonel Alexei Leonov, cosmonaut of the Soviet Union. The award was given "for their outstanding command piloting activities on the Apollo Soyuz Test Project, an important and difficult step in manned space flight. During the project's operation, for the first time in history, two spacecraft of different design and from launching pads 6,600 miles apart, met in space, docked, transferred crews between the two craft—and then undocked and returned to Earth. The NASA Apollo spacecraft lift-off took place July 15, 1975, at Cape Canaveral, Fla. Approximately seven-and-a-half hours after, the Soviet Union's Soyuz rocketed into orbit from Beikoum Cosmodrome in the Kazakhstan Soviet Republic." This marks the first time a pilot of the Soviet Union has received the trophy.

Commanders of Apollo Soyuz Test Project—Recent winners of the 1976 Harmon Astronaut's Trophy as they looked during the 1975 United States-Soviet Union space venture. Col. Alexei Leonov is at left, Maj. Gen. Thomas P. Stafford (U.S.A.F.) at right.

The Harmon trophies are awarded in four categories—aviator, astronaut, aeronaut and aviatrix—and generally are presented to recipients by the President or the Vice President. Eight Presidents of the United States and three Vice Presidents have presided at the Harmon presentation ceremonies, beginning with Calvin Coolidge.

The trophies are named after the late Colonel Clifford B. Harmon, pioneer American balloonist and aviator, after whom the city of Harmon, N.Y. is named.

Mysterious Celestial Objects Under Observation

Some of the most mysterious astronomical objects in the universe will be among the observation targets of the six NASA rockets launched from Australia last February.

NASA's Goddard Space Flight Center is conducting the project in cooperation with the Australian government, the University of Adelaide and several U.S. universities and scientists. The Goddard project manager is Richard M. Windsor.

The investigations are as follows:

- One of the studies, conducted by Columbia University, involves "bursters" or bursting X-ray stars. These sources emit powerful bursts of energy, observed in the X-ray part of the electromagnetic spectrum. They were extensively observed by NASA's Small Astronomy Satellite-3 last year. Although speculation has been rife, no one knows what they are. Dr. Richard Wolff of Columbia University's Astrophysics Laboratory says these intense and unusual X-ray sources release energy bursts a million times greater than those coming from our Sun in the same time period. So far the bursts have been measured in seconds. Wolff wants to find out if they also emit energy in milliseconds at irregular intervals. If so, this could mean they are "black holes," celestial objects with such density that not even light rays can escape. A teaspoon of material from a black hole would weigh many tons. If they are neutron stars, which are extremely dense gravitationally collapsed stars believed to be the result of supernovae, they will have regular rotation rates and emit signals measured in seconds.
- Dr. Gilbert Fritz, of the U.S. Naval Research Laboratory will be flying X-ray astronomy payloads in two rockets. He will be looking at the Large Magellanic Cloud and the Coma Cluster of galaxies. In observing the Magellanic cloud, he

will look for new X-ray stars to compare their distribution, luminosity, temperatures and periodic or random X-ray fluctuation with similar factors in the stars of our own galaxy. Millions of stars are present in what is called "The Bar," a cigar-shaped swarm of stars at the center of the Large Magellanic Cloud where an X-ray source has been reported. Fritz's observations will determine whether the Magellanic Cloud is similar to our own galaxy. It has several X-ray sources in close proximity to the galactic nucleus where star density is high.

- A second NRL payload will scan the Coma Cluster of galaxies, a well-known X-ray source, to create an X-ray picture of the cluster. An X-ray picture will enable scientists to test theoretical models of the origin of the hot (100 million degrees Kelvin) intergalactic gas producing the X-rays.
- Dr. Warren Moos of Johns Hopkins University will be looking at nearby Alpha Centauri and other stars similar to our Sun. Alpha Centauri-A, 4½ light years away, is called the twin of our Sun and is believed to be about twice its age. Moos will look for evidence of a corona in far ultraviolet light. None has ever been seen. The results of this observation may give us a better idea of what our Sun will be like in the future.
- Another Johns Hopkins investigator, Dr. Paul Feldman, will be flying instrumentation designed to make accurate ultraviolet measurements of early or "hot" stars. These stars will be used for inflight calibration of satellite-borne ultraviolet telescopes. An extreme ultraviolet instrument also will look at emissions from white dwarf companion stars in binary systems.
- A Goddard scientist, Dr. Andrew M. Smith, will be looking at the Large Megellanic Cloud with a Schwarzchild camera equipped with utlraviolet filters. He will be studying the distribution of hot stars, young supernovae remnants, galactic dust, high-energy gas and other celestial phenomena.

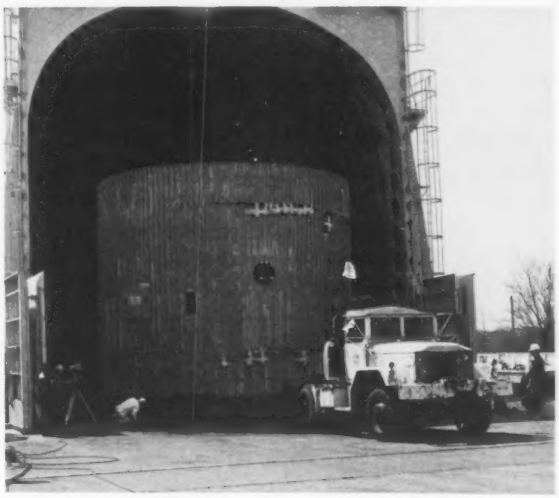
Space Telescope Project Advances

A Space Telescope project office has been established at NASA's Marshall center. Director Dr. William R. Lucas said it will implement the NASA lead center assignment for the project. The office has the responsibility for requirements, direction and all functions related to the management of Space Telescope activities.

William C. Keathley has been named manager of the new office and James C. McCulloch is his deputy manager. Both served in similar capacities on the Space Telescope task team. Keathley came to the Marshall center in 1966 and served as project manager for the Apollo telescope mount experiments flown on Skylab. He also was chief of the optical telescope assembly office.

With the Marshall center since 1961, McCulloch worked in the Saturn IV-B office, and on the Shuttle task team until 1973 when he was appointed to the Space Telescope task team.

The Space Telescope will be a long-lifetime optical observatory which will provide an observational capability far beyond that reached by ground observatories. Free of the blurring and absorbing effects of the Earth's atmosphere, it will reach some seven times deeper into space, increasing the known volume of the universe by more than 350 times. After its launch by the Space Shuttle late in 1983, it will be periodically updated and maintained through on-orbit revisits.



Test Article Docks at MSFC—The first of four major pieces of test hardware for the Space Shuttle External Tank recently was shipped by barge from the Michoud Assembly Facility to the Marshall center. The intertank structural test article arrived March 12 at the center's dock on the Tennessee River. The New Orleans-to-Huntsville route, up the Mississippi, Ohio and Tennessee Rivers, is the same route used to ship Saturn stages to Marshall for testing during the Saturn/Apollo program. The other test articles, the liquid oxygen tank, the liquid hydrogen tank and another intertank, will arrive by barge later this year.

Prospectus

NASA's Scientific Mission

Science at NASA is carefully distinguished from technology and development. Where *science* relies on theory, repeatability and predictability to acquire and organize new knowledge in an orderly way, *technology* converts the knowledge acquired by science into tools and devices for specific usages, and *development* applies the tools and devices of technology to the solution of specific problems. These distinctions apply across the whole range of NASA activities in both aeronautics and space.

A rough parallel to this relationship between science, technology and development logically occurs in NASA's lunar and planetary program under the headings: reconnaissance, exploration and intensive study. In general, reconnaissance is carried out by flyby spacecraft, followed by orbiters and atmosphere probes on exploratory missions, then landers and sample returns for intensive study.

By reconnaissance we acquire new knowledge of what a planet is like and enough information about its character and environment to allow us to proceed to the next stage: exploration of the planet.

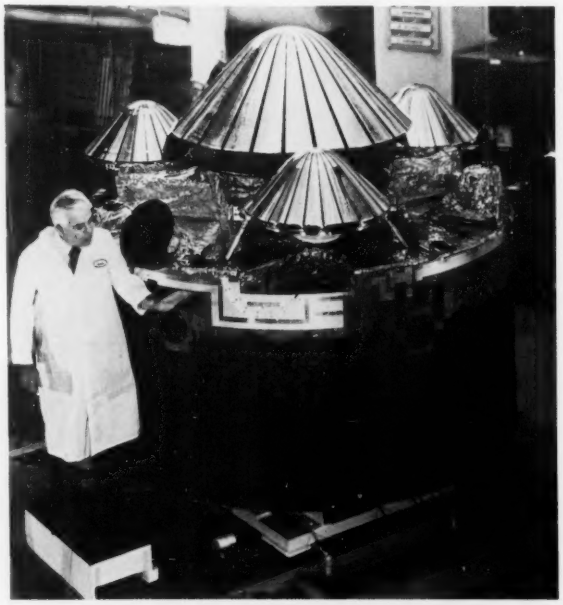
Exploration converts that knowledge into the means by which we can systematically discover and understand the processes, history and evolution of the planet on a global scale.

The final step, intensive study, applies the results of exploration to the pursuit of sharply formulated specific problems of great importance.

As of this writing NASA has completed the *reconnaissance* of the inner planets. The *exploration* of the inner planets began with the Viking landings on Mars and continues with the approved Pioneer Venus mission, which involves an orbiter and multiple atmospheric entry probes to be launched in 1978.

We are planning to continue our exploration of Mars after the Vikings go silent, probably this year. A recent modification of our budget for fiscal year 1978 provided funds for defining hardware and science requirements for a combination orbiter and mobile lander proposed for launch in 1984, and a 1988 intensive study mission to return a sample of the enigmatic Martian soil to earth for examination and analysis.

Reconnaissance of the outer planets began with ground-based observations and the flybys of Jupiter by Pioneers 10 and 11 in the early 1970s. These



Pioneer-Venus Spacecraft—Charles Hall, project manager for the Pioneer-Venus mission, stands next to the thermal model of the satellite that will carry four probes to near Venus. The probes, in conjunction with a Venus orbiter spacecraft, will carry out a detailed scientific examination of the atmosphere and weather on Venus. The multiprobe spacecraft consists of a bus, a large probe and three identical small probes, each carrying a complement of instruments.

identified the radiation environment of Jupiter and supported the design of instruments and missions for the Voyager explorations of Jupiter and Saturn to be launched this summer.

These prospective odysseys serve to define the best current example of NASA science in action and as such deserve closer attention.

The Voyagers are scheduled to be launched from the Kennedy Space Center on Aug. 20 and Sept. 1. Both spacecraft will first fly past Jupiter and obtain information on its atmosphere and magnetosphere, and make observations of its satellites. Using the gravity assist from Jupiter, the first spacecraft will go on to Saturn to study the planet, its rings and its satellites. If the first spacecraft succeeds, then the second Voyager will be retargeted at Saturn so that the gravitational swingby will subsequently direct it on to Uranus. A major topic of investigation will be the properties of the planetary satellites and the rings of

Saturn because the satellite systems of Jupiter and Saturn are analogous in many ways to miniature solar systems.

The trajectories of the two spacecraft have been designed for coverage of as many of the numerous satellites as possible, as well as for observations of the planets themselves. The first Voyager will give us our first close-up views of the inner Jovian satellites (Amalthea, Io, Europa, Ganymede, and Callisto) and the second will provide different views of all of these except Io. At Saturn, both spacecraft will pass close to Tethys, Mimas, Enceladus, Dione, and Rhea, and the first Voyager will make a close encounter with Titan. Titan is the largest satellite in the solar system, and is known to have an atmosphere comparable in density to that of the Earth as well as a very involved organic chemistry.

A second major thrust of the voyager explorations is atmospheric and planetary science. Gravitational and magnetic field data will provide important clues to the internal structure and dynamics of the outer planets. Some instruments will measure and map the heat distribution of the planets, and determine whether internal sources of heat are important—on Jupiter, for instance. Other remote sensing experiments will allow a detailed study of the atmosphere, including dynamics, thermal and density structure, and composition. The composition of the outer planets is of particular importance to understanding the early history and composition of the solar system.

The Voyager spacecraft are being assembled and tested at NASA's Jet Propulsion Laboratory. They incorporate special life-prolonging technologies such as redundant systems, environmentally tailored circuits and computers able to diagnose and correct their own failures. Such capabilities are required by the fact that they must be able to survive, observe and communicate twice as long as their Pioneer predecessors or about 12 years after launch.

It seems appropriate to conclude a Prospectus on Science at NASA as illustrated by the Voyager explorations with a perhaps not entirely fanciful concept which tends to place our whole effort in space in proper perspective.

Any galactic or even extra-galactic intelligence monitoring our Earth with its bio-sensors would have found no life for the first billion years following the formation of the planet out of the original solar gas cloud. But after that it might have picked up the first stirrings of the first replicating micro-organisms drifting near the surface of the primal oceans. As the eons whirled away, the appearance of larger forms would have been recorded, progressing through the hundred-million-year dominance of the giant reptiles to the first appearance of the primates from which we came.

Soon then, that assumed intelligence would have noted first the camps, then villages, the towns, the

A Space Voyager—A prototype Voyager spacecraft is shown at NASA's Jet Propulsion Laboratory as it successfully passed vibration tests which simulated the expected launch environment. The large parabolic antenna at the top is 3.7 meters (12 feet) in diameter and will be used at both S-band and X-band radio frequencies for communicating with Earth over the great distances from the outer planets. The spacecraft will receive its electrical power from three nuclear power sources (at lower left). The shiny cylinder on the left side under the antenna contains a folded boom that will extend after launch to hold a magnotometer instrument 13 m. (43 ft.) away from the body of the spacecraft. The truss-like structures on the right is the stowed instrument boom that supports three science instruments and a scan platform.

Prospectus

—Cont.

cities and the nations of people, seen the continents laced with ribbons of concrete and steel, watched the bridges being thrown across the great rivers, the canals dug to join the seas, the forests despoiled and huge areas of fertile soil paved over. It would have listened to the chaotic jumble of electronic emissions, seen the flashes of nuclear explosions and perhaps sadly recognized the first steps in the self-destruction of planetary life.

But almost certainly it would have marked for emphasis in some special way the decades of the mid-twentieth century when, for the first time, the life that began so long ago as drifting single cells was able to leave the planet of whose chemicals it was formed and begin tentatively to explore the universe, doggedly searching back among the stars for the explanation of its own origins.

What lies in store for the sons and daughters of Earth's inhabitants beyond the shores of Earth nobody now living can surely say. The only certainty, given humanity's restless, urgent, ceaseless search for knowledge is that one day we will know.

For us at NASA and for all who share in any way this greatest of all adventures, it is enough to be counted in the vanguard of the searchers.

Television Celebrity Helps NASA Recruit Astronauts

A contract recently awarded by NASA to the Women in Motion Production Co. of Los Angeles, is for services associated with acquainting potential minority applicants with opportunities available to them in the Shuttle Astronaut Recruitment Program.

Under terms of the contract, Nichelle Nichols, one of the stars (Lt. Uhura) of the NBC television series "Star Trek," will be available for contacting community organizations, colleges, institutions and individuals to familiarize them with the requirements for qualifying as Space Shuttle astronauts.

Nichols is the executive vice president of the contracting firm. Her duties under terms of the agreement will include contacting students at minority and non-minority schools at the college and university level. In addition she will seek appearances on major programs broadcast by major television networks.

"We want to make sure that the recruitment is brought to the attention of minorities and that the word gets around that NASA really wants to get applications from qualified minorities and women," an agency official explained. "We believe Ms. Nichols is uniquely qualified to do this."

Nichols will establish personal contact with NASA officials charged with astronaut recruitment so she is familiar in detail with the status of the applications, and has a firm understanding of the functions and duties of Shuttle crew members.

Her activities under the contract will be concentrated in the months before June 30 this year, the last date for filing applications in the current Shuttle crew recruitment program.

Nichols is a member of the board of directors of the National Space Institute, Arlington, Va.

Briefing for Star Trekker—Nichelle Nichols was briefed by astronaut Alan Bean at the Johnson Space Center before she began a nationwide tour for NASA. Her new company seeks to acquaint potential minority and women applicants with the Space Shuttle program.

Landsats Monitor Irrigation Systems

Another unusual job for a NASA satellite—the keeping of tabs on irrigation systems in Nebraska—is now underway. State officials say the method is not only the fastest and least expensive, but as accurate as any other available system. The count of center-pivot irrigation systems in the state now amounts to some 12,000 and the number is growing at the rate of 40 to 60 percent annually.

For those reasons, yearly inventories are extremely necessary says Marvin P. Carlson, assistant director of conservation and survey at the University of Nebraska. He points out that the systems, which consist of irrigation pipes mounted on wheels above the ground, use enormous amounts of water from the wells in the centers which feed the pipes). Large amounts of fuel

also are needed to move the pipes in a circle around the well.

The reason it is so important to know how much center pivot irrigation is being installed each year is that state legislators must have an idea of how much water is being expended from a constantly drought-lowered water table in case there is a need for water allocation.

In addition, the energy crisis has made it important for fuel distributors to know how fuel is being used in the state. With some 1.5 million acres of land irrigated by the center-pivot systems the diesel fuel or equivalent used is calculated at more than 83 million gallons a year. Water use is estimated at 407,000 gallons per acre each year.

Even future planning and real estate prices have been affected by the amount of irrigation in the state. As a result, the Landsat imagery is important to highway and transmission lines planners as well as to farmers and urban developers.

By using NASA's Landsat 1 and 2 Earth resources spacecraft imagery in visible and near infrared pictures of the state taken twice every 18 days, the circular irrigation patterns can be seen clearly. By examining the imagery taken from some 920 kilometers (570 miles) high, an inventory of the entire state can be had in about 150 hours. An inventory accuracy of about 95 percent has been achieved for the entire state; accuracy has reached 98 percent for a number of areas.

NASA's Goddard Space Flight Center is responsible for Landsat project management including data acquisition and distribution.

Gowers Elected to Spanish Program

Carmen Gowers, Spanish-Speaking Program Coordinator of the NASA Headquarters EEO Program Office has been elected vice-chairperson of the Washington Council of Spanish-Speaking Program Coordinators for the Calendar Year 1977. She is one of the three elected officers of that body. The council is an organization sponsored by the U.S. Civil Service Commission within the context of the Federal Equal Opportunity effort. It consists of 174 representatives from all federal agencies in the Washington, D.C. metropolitan area. The council formulates policies and plans of action to address the employment concerns of Hispanic Americans in the metropolitan area.

Award Granted to Mogavero

At a recent meeting, NASA's Inventions and Contributions Board established a precedent by recommending that a monetary award be granted to a current member of the board, Louis N. Mogavero, better known as the director of the technology utilization office.

The award was subsequently granted and a check and certificate were presented to Mogavero by Herbert J. Rowe, Associate Administrator for External Affairs, at the board's meeting in February 1977.

Mogavero became eligible for consideration for a monetary award following the filing of a patent application for an invention entitled: "Tracking System for Moving Subjects," for which he was a co-inventor in conjunction with three employees of the National Bureau of Standards. They also were granted Space Act Monetary Awards.

Invention Wins Prize—In recognition of his accomplishment, Louis N. Mogavero (right) receives an award check and certificate from Associate Administrator for External Affairs Herbert J. Rowe.

Contractor News

McDonnell Douglas Technical Services Co., Inc., Spacelab Integration Division, Huntsville, Ala., has been awarded a contract for NASA's Spacelab integration. Period of performance of the contract is from March 1977 through December 1983, including an option period beginning in April 1981. The cost-plus award-fee contract is worth an estimated $43½ million, including fee. The integration contract is for the design, development and fabrication of most of the Spacelab hardware for which NASA is responsible including crew transfer tunnel, verification flight instrumentation, mockups and ground support equipment. Part of the work will be performed at the Marshall center, part at the Kennedy center.

The Hughes Aircraft Co., Space and Communications Group at El Segundo, Calif., has been chosen by NASA for negotiation of a contract for a thematic mapper instrument to be installed on Landsat-D. The fourth in a series of earth resources technology satellites, Landsat-D is scheduled for launch in early 1981. The basic contract is for instrument design, development, fabrication, assembly, test and qualification of hardware. Options in the contract are for an additional flight unit, an additional set of bench test and calibration equipment, and support services; and for two additional flight units and support services. The cost-plus-award-fee contract for the basic effort and options covers respective costs of $27½ million, $10¼ million and $16 million. Completion and delivery of the prototype flight model is expected in the last half of 1980.

The General Aviation Design and Analysis Center at Ohio State University Airport in Columbus has been certified by NASA to perform analysis studies for single element airfoils. The move is the first step toward providing a complete service to the general aviation community. To follow will be a certification for limited single element design; soon thereafter will be certification for aerodynamic analysis with flaps and simple aerodynamic controls. The center was developed under a contract between the Langley Research Center and Ohio State University's Aeronautical and Astronautical Research Laboratory. The contract includes a three-year effort to provide services directly to aircraft designers and manufacturers. Services will be provided to industry on a fee charge basis and will include computational analysis and technical assistance, consultation for airfoil wind tunnel and flight test.

McDonnell Douglas Corp. at Huntington Beach, Calif., and NASA have signed an agreement under which, as a commercial venture, the company will design, manufacture and test a solid-propellant upper-stage system, including integration services to be used on Space Shuttle missions for heavy Atlas-Centaur class payloads. Similar to an agreement for lighter payloads reached last year, this one provides for an upper stage that would handle payloads weighing up to 2,000 kilograms (4,400 pounds).

A Martin Marietta Corp. Michoud operations contract has been amended to add 3.7 million to the basic facilities contract for fabrication of external tanks for the Space Shuttle. The contract now totals more than $30 million.

The Illinois Institute of Technology Research Institute at Chicago won a one-year contract for the establishment of a manufacturing applications team as part of NASA's technology utilization program. The $150,000 contract was awarded by the Marshall Space Flight Center. Under its terms, the new team will review NASA-developed technology and identify techniques or processes that may be useful in solving problems unique to the manufacturing industry.

Hamilton Standard Division of United Technologies Corp. has received a contract from the Johnson Space Center to develop spacesuits for the Space Shuttle crew. The initial value of the contract is $2 million, the total value of the final definitive contract is expected to run about $18.5 million. The system will consist of a space-suit with life-support backpack for astronaut activity outside the orbiter's pressurized cabin. A $2.75 million contract also was awarded to the same company to develop and produce a Space Shuttle portable oxygen system.

American Airlines is responsible for maintenance and operations support of NASA's 747 Shuttle carrier aircraft under an $806,000 contract awarded by the Johnson Space Center.

The Lockheed Electronics Co. has had its contract renewed by the Johnson Space Center for support services at the White Sands (N.M.) test facility. The contract is worth $12 million. ■■■

Minority Firm Gets Million Dollar Contract

One of four minority firms performing work at the Marshall Space Flight Center's Michoud Assembly Facility in New Orleans, the Robinson Printing Co., Inc., of Huntville, Ala., recently was awarded the largest contract ever given to a minority business by the center under Section 8(a) of the Small Business Act.

The firm won a $998,474 contract to perform reproduction, documentation and photographic services at Michoud.

Robinson Printing was not unfamilar with SBA Section 8(a) provisions, having previously won Marshall center contracts for printing and technical writing. The firm currently is under contract to provide graphic arts for the Spacelab program at the center.

The Alabama-based company began in 1969, when Dinsimore G. Robinson and his father formed the Robinson Printing Company as a partnership in Huntsville. Later the firm became a corporation with the younger Robinson as owner and president.

With assistance from the Marshall center, Robinson took advantage of an opportunity in 1974 and was

Handling A Million Dollar Contract—Robinson Printing Company owner and president, Dinsimore G. Robinson (left), discusses work at his Michoud assembly facility plant in New Orleans, La., with his supervisor of reproduction, Rodney Kelley. The firm was recently awarded a contract that will amount to almost $3 million over a three-year period.

selected as a subcontractor by Boeing Services International, Inc., to provide manpower and management of printing, reproduction and photographic services at the Michoud facility. That contract continued through 1975 and 1976.

In late 1976, the Marshall center determined that it would be in the best interest of the government to expand the Michoud service contract through the Small Business program. Robinson Printing, with its excellent record of performance, was awarded a contract for an expanded scope of work valued at almost $1 million for the first year and with options for two additional years.

The firm's work force has grown to 45 employees and a determined effort has been made by its management to obtain the best professional employees available. The most recent addition to the payroll is an honor graduate of Duquesne University who is an expert in management and contract administration.

Robinson, 38, plans to expand his business in both the commercial and government arenas. Last year, about 20 percent of the firm's sales was commercial with the balance in government contracts. Robinson believes that the highly qualified professionals he is adding to his staff from time to time will bring about the expansion in sales that he is seeking.

"This is an excellent example of a small business minority firm taking advantage of an opportunity in its field of interest and expertise," said Conrad Walker, Marshall center minority business specialist. "Dinsimore Robinson, however," he continued, "would be the first to admit the necessity for support and cooperation from NASA and the Small Business Administration."

Transcontinental Meetings without Travel

Through use of the Communications Technology Satellite, Patricia Roberts Harris, Secretary of the Department of Housing and Urban Development, recently met face to face with a group of mayors at NASA's Ames Research Center. They were attending a leadership meeting of the United States Conference of Mayors in nearby San Jose. She was in Washington, D.C.

Thanks to the CTS, which is a joint U.S. and Canadian project, Harris met with the group for 45 minutes. She answered questions about urban development urban renewal and rehabilitation, financing and housing assistance, and a broad range of plans for "urban policies in the federal sector," including her intention to involve the private sector as partners with the federal government in urban rehabilitation efforts.

"It really worked splendidly," Harris said. "They asked the questions. I responded. They could see me and I could see them." Saved, she pointed out, were time, money and personal energy. Harris said she looks forward to having similar interchanges with other groups through use of the CTS satellite.

The CTS was launched by NASA from the Kennedy Space Center in January 1976. A cooperative effort between Canada's Department of Communications and NASA, its services are shared by Canada and the United States on a 50-50 basis on alternate days of the week.

The Canadians built and integrated the spacecraft and NASA supplied the 200-watt traveling wave tube, the most powerful transmitter launched to date. The linkup with the Secretary of HUD and the mayors' meeting more than 4,800 kilometers (3,000 miles) away in California was done by means of a portable earth terminal that rides in a bus.

Secretary Harris spoke from the bus which was parked next to the HUD building at 7th and E Streets, S.W., in Washington. The HUD parking lot is the first stop for the NASA bus which is based at NASA's Lewis Research Center. It will travel cross-country to be used for other major teleconferences and for pro-

gram that will explore and demonstrate the potential impact—social, cultural and economic—inherent in such an inexpensive and efficient satellite communications system.

Among the potential benefits a system such as the CTS satellite can provide, using portable Earth-based terminals, area aids to education such as the ability to share limited curricular facilities and resources in remote and impoverished communities.

The system also can provide diagnostic data for hospitals and can support emergency medical treatment; and when more mobile facilities are provided, large-scale teleconferences can be held by large industrial groups, medical organizations, political meetings—even one-day national conventions. Such a system means that one day we can go anywhere and everywhere and still remain at home.

High Foreign Award to NASA Employee

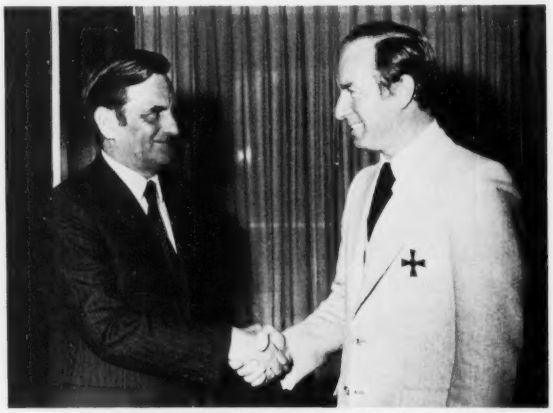
A special reception was held at the German Embassy in Washington in March at which the highest German award, the "*Bundesverdienst Kreuz*," was presented to Gilbert Ousley on behalf of the President of Germany. Ousley is the NASA Goddard Space Flight Center's project manager for the $260 million cooperative U.S.-German Helios solar probe project.

The two Helios solar probes, launched in December 1974 and January 1976, have successfully accomplished their mission of repeatedly traveling within 28 million miles of the Sun with all 10 scientific experiments performing perfectly. The extremely informative Helios mission will help scientists of both countries to better understand the dynamic transfer of solar energy from the Sun to our Earth.

Germany provided the two spacecraft and seven of the scientific experiments. The U.S. provided the Titian/Centaur launch vehicles, three scientific experiments, and the launch of the spacecraft from the Kennedy Space Center. Engineering and scientific teams from both countries worked together for about seven years to accomplish the difficult managerial and technical tasks involved.

In this unusual event involving a foreign national, the Federal Republic of Germany presented the award to Ousley for his service to Germany in providing outstanding leadership as he directed the American part of the joint program. Two earlier NASA recipients of the award are Drs. Wernher von Braun (1959) and Kurt Debus (1970).

Ousley received his B.S. and M.S. degrees from the University of Maryland. He is the recipient of the Department of Defense Meritious Civilian Service and Inventors Awards, the NASA Exceptional Service and Superior Accomplishment Awards, and the French Space Medal.



Germany Honors Gilbert Ousley—German Minister Helmut Matthias (left) presents the "*Bundesverdienst Kreuz*" (Order of Merit of the Federal Republic of Germany) award to Gilbert Ousley.

Solar Sailer Program Underway

Six design contracts for material and booms for a 160-acre Sun sail recently were awarded by NASA's Jet Propulsion Laboratory as a move toward the production of large sailing ships in space. The awards total $800,000.

The solar "sailer" would use the pressure of reflected sunlight on a mirror-like aluminized plastic surface to attract radiating photons that carry momentum and thus might propel vehicles among planets as wind does for Earthbound sailboats.

NASA revived the five-decade-old idea as part of a program involving economical ways to fly in interplanetary space on such missions as a rendezvous with Halley's Comet when it comes within 50 million miles of Earth.

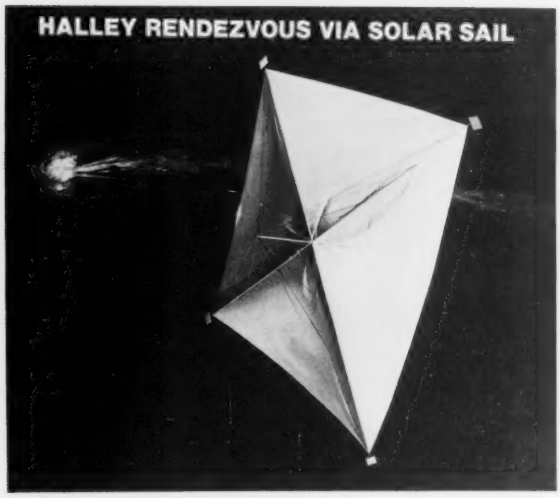
Recipients of the contracts are: E. I. Dupont Co. of Wilmington, Del., $250,000 for fabrication of one kind of candidate sail material; MacNeal-Schwendler, Los Angeles, $350,000 for helio-gyro design; International Latex Corp. of Dover, Del., $50,000 and Sheldahl Corp., Northfield, Minn., $50,000 for design of the sail material; Able Engineering, Goleta, Calif., $50,000 and Astroresearch Corp., of Carpinteria, Calif., $50,000 for design of booms.

If the immense new vehicle becomes a reality, NASA will schedule demonstrations of its operation by carrying the solar sailer into space in the Space Shuttle

orbital transport in 1981 or 1982 to be in position to intercept Halley's Comet in 1986. That feat would require a "sailing" velocity of 135,000 m.p.h. For the definitive first flight, the furled sail would be taken into orbit by the Shuttle and boosted into solar orbit, unfurling automatically.

Paul Holloway, deputy associate administrator for aeronautics and space technology at NASA, said the thinnest commercial plastic film now produced is at least 10 times thicker than NASA needs for the sail, adding that industrial chemicals probably can reduce the material to the desired thinness. Development program chief at JPL, Howard H. Haglund and his assistant, Louis D. Friedman, say their design plan calls for an 800-meter-square (2,400 square foot) plastic film sheet only 2.5 microns (one ten thousandth of an inch) thick, and ultra-lightweight extensible booms for the spar and masts.

NASA expects to be able to assess the merit of the solar sailer concept by next August.



Solar Sailer in Conjunction with Comet—An artist's concept of how the planned "Solar Sailer" might look in space as it encounters Halley's Comet in 1986. The paper-thin, reflective sail attracts momentum-carrying photons that speed the vehicle on its way through space as wind propels sailboats. The sail will measure about a half-mile on each side, and resemble a giant kite. It will have to withstand temperatures of at least 600 degrees F. for long periods. The solar sail spacecraft, to be called "The Yankee Clipper," might fly formation with the comet for weeks, even months, to study and photograph the phenomenon as it travels close to Earth.

NASA Seeks Space Telescope Proposals

NASA has invited industry to prepare bids for the procurement of major elements of the Space Telescope, which is included in NASA's Fiscal Year 1978 budget.

Requests for proposals, released to industry in late January by the Marshall Space Flight Center, call for the design, development and manufacture of the Space Telescope's support systems module and optical telescope assembly. Contracts are expected to be awarded in October or November 1977, if Congress authorizes the Space Telescope and appropriates the required funding.

The Space Telescope would weigh about 10 tons and would orbit the Earth at an altitude of about 500 kilometers (310 miles) at an inclination of 28.8 degrees to the equator. The 2.4-meter (8-foot) diameter telescope, capable of accommodating up to five different instruments at its focal plane. would be placed in orbit in 1983 by the Space Shuttle. Once in orbit, it would be operated by remote control from the ground, but would be designed to permit maintenance and the change of instruments by a space-suited astronaut. Also it would be retrievable by the Space Shuttle for return to Earth for overhaul and subsequent relaunch. These features should allow the Space Telescope to serve as an in-space astronomical observatory for a decade or more.

The Space Telescope is envisioned as a means by which scientists can study mysteries relating to the structure, the origin, the evolution and the little-understood energy processes of the universe. Such aspects could never be approached through use of observatories below the obscuring veil of the Earth's atmosphere. The telescope should enable astronomers to observe some 350 times the volume of space that can be studied through use of the largest telescopes available on Earth.

NASA issued an announcement of opportunity to the science community in February, which solicited proposals for scientific instruments to be carried on the initial launch of the Space Telescope.

Shuttle Control System Simulation Flights Scheduled

Inflight simulation of portions of NASA's Space Shuttle orbiter computer flight control system were completed in March at NASA's Dryden Flight Research Center, using a specially modified F-8 jet aircraft on three flights. Tom McMurtry and Gary Krier were the pilots.

The purpose of the flights, which simulate the maneuvers the orbiter will perform following separation from the 747 Shuttle carrier aircraft this summer is to gather data to support the Shuttle's backup flight control system.

The flight control system in the F-8, called Digital Fly-By-Wire, is similar to the primary and backup control system in the Shuttle. The conventional mechanical control systems in the aircraft have been replaced by lightweight wires and electronics to translate pilot signals to the aircraft control system. Three digital computers are used for primary control, and a three-channel analog system is available for emergency control if the digital system fails.

Both the F-8 and orbiter use similar models of the same digital computer. Parts of the orbiter computer's logic for detecting failures of sensors, such as rate gyros, accelerometers and pilot stick position, have been programmed on the F-8 computers.

The F-8 was flown along a flight path which follows a race-track pattern, with the simulated separation of the 747 and orbiter occuring about 13 kilometers (eight miles) to the right and parallel to the landing runway on the dry lakebed at the Edwards Air Force Base. After the separation point, the F-8 pilot performed a series of test maneuvers similar to those which the orbiter pilot will perform, to obtain data on the flight control system.

Data were recorded and analyzed after the flight to determine the effect of pilot maneuvers and turbulence on the computer's ability to detect failures and avoid giving false alarms.

The F-8 pilot then initiated the first of two 90-degree turns to the left which aligns the aircraft with the lakebed runway at an altitude of 2,000 meters (6,500 feet), about 14km. (nine miles) from the point where the orbiter would touch down. A preflare maneuver was made at an altitude of 270 m. (900 ft.)

Inventions and Contributions Board Monetary Awards

The Inventions and Contributions Board has recommended that monetary awards be granted to the NASA employees and NASA contractor employees identified below for scientific and technical contributions to space and aeronautical activities. The recommendations were approved by the Administrator and the awards have been made.

Innovator(s)	Title of Invention and Contribution
AMES RESEARCH CENTER	
John Dimeff	Optically Selective Acoustically Resonant Gas Detecting Transducer
Robert D. Lee, Dale I. Shute, Robert J. Hudock	Reference Apparatus for Medical Ultrasonic Transducer
Richard F. Haines	Optical Instrument Employing Reticle
Yutaka Matusumoto, Henty Lum, Jr.	A Sampling Video Compression System
DRYDEN FLIGHT RESEARCH CENTER	
Merle A. Economu	Wire Stripper
GODDARD SPACE FLIGHT CENTER	
James P. Marshburn	Remote Readout Levelness Sensor-Heat Pipe System
R. T. McKenna	Automatic Character Skew
Ronnie R. Rippy	Linear Phase Demodulator
Leonard F. Deerkoski	Pseudo Noise Code & Data Transmission Method and Apparatus
Thomas LaVigna	A Non-Saturating Parallel Converter Without Collector Current Overlap
Maxwell Strange	Self-Regulating Proportionally Controlled Heating Apparatus and Technique
HEADQUARTERS	
Louis N. Mogavero	System and Method for Tracking Signal Source
JOHNSON SPACE CENTER	
Robert L. Dotts, Robert J. Maraia, George Strouhal, Donald J. Tillian, James A. Smith, Jack Naimer, William C. Schneider, Ivan K. Spiker, Lubert J. Leger	Nomex/Felt Thermal Protection System
Jack A. Kinzler, James T. Heffernan, Leroy G. Fehrenkamp, William S. Lee	Surface Finishing
Jack Naimer, Matthew I. Radnofsky	High Visibility Air Sea Rescue Panel
LANGLEY RESEARCH CENTER	
David B. Robelen	Deploy/Release System
LEWIS RESEARCH CENTER	
Frederick T. Schuller, Warren A. Moore	Journal Bearings
Frederick Schuller, Warren A. Moore	Lubricated Journal Bearing
Frderick Schuller, Warren A. Moore	Fluid Journal Bearings
Donald L. Alger, William B. Schwab, Edward R. Frunam	Closed Loop Spray Cooling Apparatus
Robert E. Oldrieve, Charles P. Blandenship	Tantalum Modified Ferritic Iron Base Alloys

Robert D. Ingelbo ..... } Splash Groove Fuel Injector
Carl T. Norgen ..... }

John C. Freche ..... } Nickel Base Alloy
William J. Waters ..... }

Donald Beremand ..... }
Lloyd I. Shure ..... } Direct Heating Surface Combustor
Thaddeus S. Mroz ..... }

John A. Woollam ..... Atomic Hydrogen Storage Method and Apparatus

Robert Stienberg ..... } Method of Forming Metal Hydride Films
Dale W. Cooper ..... }
Donald L. Alger ..... }

Dr. Cecil J. Marek .... Fuel Combustor

Dean W. Sheibley ..... } Gels as Battery Separators for Soluble Electrode Cells
Randall R. Gahn ..... }

MARSHALL SPACE FLIGHT CENTER

Edward L. Shriver ..... Charge Injection Method and
Orville Weaver ..... Apparatus of Producing Large Area Electrets

Lott W. Brantley, Jr. .. } Pressure Shaped Reflector Apparatus
Robert W. Rood ..... }

Page K. Evans ..... A Device for Tensioning Test Specimens Within An Hermetically Sealed Chamber

Dan H. Dane ..... Oscillating Vane Engine

James M. Zweiner ..... Real Time Reflectometer

Frank J. Nola ..... Tachmeter

E. L. Shriver ..... Two Stage Light Gas-Plasma
David W. Jex ..... Projectile Accelerator

Thomas R. Edwards .. } Filtering Device
Hugh W. Zeanah ..... }

Launches for 1977

Name	Launch Date	Vehicle	Range	Mission Remarks
NATO-III B	Jan.	Delta	ETR	Second communications satellite in synchronous orbit to perform communications relay for NATO. Reimbursable.
Palapa-B	March 10	Delta	ETR	Back-up satellite for Indonesian domestic communications network. Reimbursable.
GEOS/ESA	April 20	Delta	ETR	ESA spacecraft to conduct scientific investigation of waves and particles in magnetosphere. Reimbursable. Failed to reach correct orbit.
GOES/NOAA ...	May 25	Delta	ETR	Second operational satellite to provide continuous daytime and nighttime global cloud cover observations for NOAA. Reimbursable.
Intelsat IVA-C ...	May 26	Atlas/Centaur ..	ETR	Follow-on series of improved communications satellite for Comsat. Reimbursable.
HEAO-A	June 30	Atlas/Centaur ..	ETR	High Energy Astronomical Observatory to study energetic radiation from space.
OTS/ESA	June 16	Delta	Delta	Orbital Test Satellite. ESA experimental communications satellite. Reimbursable.
GMS-A	July	Delta	ETR	Geosynchronous Meteorological Satellite. Japanese portion of global network of geostationary environmental satellites. Reimbursable.
SIRIO-A	Aug.	Delta	ETR	Italian project to investigate radio propagation, trapped radiation flux, magnetic field intensity and variation, and the primary electron energy spectrum. Reimbursable.
Meteosat	Aug.	Delta	ETR	ESA meteorological satellite. Reimbursable.
Voyager	Aug.	Titan III ..... Centaur	ETR	Jupiter/Saturn mission to conduct exploratory investigation of the Jupiter and Saturn planetary systems and the interplanetary medium out to Saturn.
Voyager	Aug.	Titan III ..... Centaur	ETR	Same as above.
Landsat-C	Sept.	Delta	WTR	Third Earth resources technology satellite.
RCA-C	Sept.	Delta	ETR	Third domestic communications satellite for RCA. Reimbursable.

Did You Know?

A new musical composition, entitled "Gemini Concerto," makes up the sound track for the technical version of the NASA film "Space Shuttle." The film—in two versions—was written by Byron Morgan and produced by the audio visual division for the Space Shuttle program office. The public affairs version of the work uses a different sound track. The film is narrated by the well-known Peter Thomas and the concerto was composed by John Pearson. The music was scored and recorded in London by Pearson and was arranged for the film by George Craig of Music Sound Track Services, New York City. Wayne Miller, Space Shuttle program office, was technical adviser. Loan copies of the film may be obtained from the Space Shuttle program office.

The Johnson Space Center again is in the movies. This time, part of the CBS-TV movie "Red Alert" is being shot at the center. The plot of the film involves a sabotage attempt on a nuclear plant. One of the stars is Adrienne Barbeau, well known as a featured player in the television series, "Maude."

The Astronaut Candidate program office reports a total of 1,545 applications received by March. Of the total, 1,267 applied for mission specialist, 278 for pilot. Women's applications totalled 198.

Night owls may be interested in knowing that a NASA-produced television sign-off (or on) two-minute film short has caught the fancy of the stay-up generation. The Warner Brothers recording group called "America" sings the song "Here's to the Lonely People," as an accompaniment to filmed scenes from Apollo missions and of people on Earth. The song was suggested to NASA motion picture director Byron Morgan by his teen-age daughter who urged her father to listen to the soft rock song. Morgan found the song perfect for the picture. Many local TV stations are running the film.

A call-for-papers was issued by the American Astronautical Society for its 23rd annual meeting, to take place Oct. 18-20 at the airport Hilton Hotel in San Francisco. Abstracts of 200 to 500 words were requested by May 1; final manuscripts are due Sept. 1. The general theme of the conference is "the Industrialization of Space—Planning for Profit at the High Frontier." The AAS meeting is co-sponsored by the American Institute of Aeronautics and Astronautics, the Institute of Electrical and Electronics Engineers, the British Interplanetary Society, the International Institute of Space Law, the American Society for Quality Control, Stanford Research Institute, the L-5 (space colony) Society and and the National Space Institute.

Energy, a free exhibit sponsored by the Energy Research and Development Administration, opened April 1 and ran through April 7 at the Kennedy Space Center. All types of energy currently in use were covered in the exhibit, as well as potential energy sources. ■■■

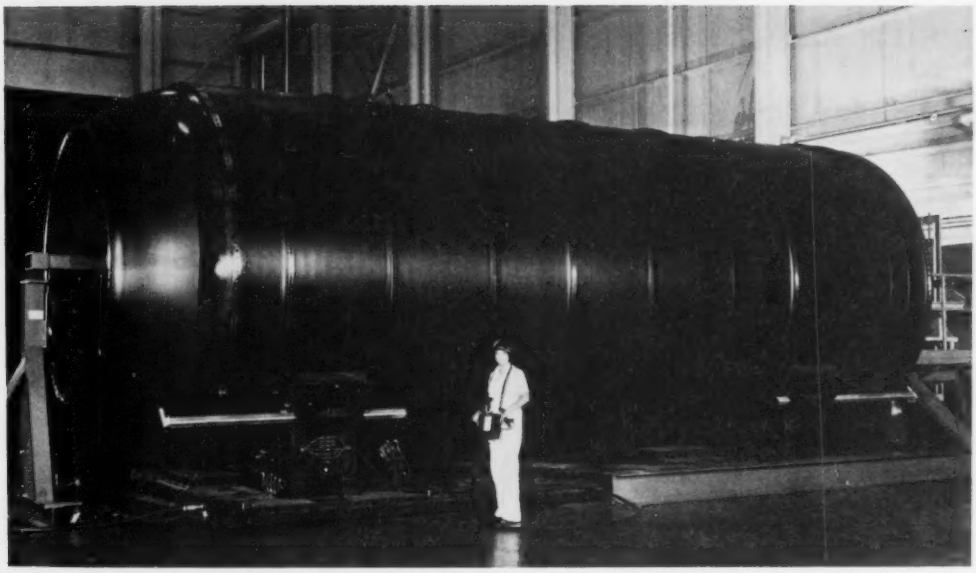
New Appointment at Headquarters

Major General Kenneth R. Chapman, USAF (Ret.) became NASA's Assistant Administrator for the Office of DOD and Interagency Affairs April 1. He succeeds Lieutenant General William W. Snavely, USAF (Ret.), who left NASA in September 1976 to accept a position in Saudi Arabia.

Chapman comes to NASA from the Nuclear Regulatory Commission, where he was director of the Office of Nuclear Material Safety and Safeguards afted he retired from the Air Force in 1975.

A native of Summerfield, Kansas, he attended Kansas State University in Manhattan and was graduated from the Military Academy as a second lieutenant with a pilot rating. He obtained an M.S. degree in nuclear chemistry from the University of California at Berkeley in 1954.

His earlier assignments have included: staff scientist at the Los Alamos Scientific Laboratory with duties involving the nuclear rocket program; consultant to the nuclear rocket program at Jackass Flats, Nevada; chief of special projects at the Air Force Special Weapons Center, involving space physics research in the use of satellite and probe payloads; deputy branch chief, Space Nuclear Auxiliary Power Program, Reactor Branch, Division of Reactor Development, Atomic Energy Commission; project officer for the first power reactor operated in space; Commander of the Air Force Eastern Test Range, with additional duties as Department of Defense Manager for Manned Space Flight Support operations; and Assistant Deputy Chief of Staff, Research and Development, headquarters USAF.



Easy Lifting—This 150-ton casting segment for the Space Shuttle solid rocket booster floats on a cushion of air on its transporter/dolly in Thiokol Corp's plant in Brigham City, Utah. The air suspension system of the dolly allows one person to move and position the segment around the floor. The dolly also has air bearings in the cradle to allow the segment to be rotated. To move to another building, the dolly is raised, attached to a towing device and moved in a tractor trailer fashion. Each booster consists of four casting segments two of which will be used for every Shuttle flight. After each flight, the motor segments will be returned to Thiokol Corp. for refurbishment, reloading and use for another Shuttle flight. Marshall is responsible for development of the solid rocket booster.

Patents for Inventions from NASA Research

The Office of General Counsel, NASA Headquarters, announces that the following U.S. patents have been issued by the U.S. Patent Office to NASA for inventions resulting from NASA research. Inquiries concerning them should be directed to the attention of the NASA Patent Counsel for the indicated installation.

Inventor(s) and Employer(s)	Title & NASA Docket	Patent No.	Installation
Leroy H. Smith, General Electric Company, Cincinnati, Ohio	Reverse Pitch Fan with Divided Splitter	4,005,574	LERC
Howell D. Garner, NASA/LARC	Magnetic Heading Reference	4,006,631	LARC
James W. Brantley, Thomas P. Irwin, General Electric Co., Cincinnati, Ohio	Leading Edge Protection for Composite Blades	4,006,999	LERC
John F. Sutton, NASA/GSFC	Deflection System for Cathode Ray Oscilloscope	4,007,400	GSFC
Willard F. Libby, Carl A. Jensen, Lowell L. Wood, Univ. of California Los Angeles, Calif.	Continuous Plasma Laser	4,007,430	NRLO
Glen B. Shelton, Sperry Rand Corp., Space Support Div., Huntsville, Alabama	Notch Filter	4,007,434	MSFC
Bruce W. Webbon, NASA/ARC	Tubular Sublimator/Evaporator Heat Sink	4,007,601	ARC
George L. Shillinger, Jr., NASA/ARC	Spring Operated Accelerator And Constant Force Spring Mechanism Therefor	4,007,623	ARC
Norman E. Sorensen, NASA/ARC Eldon A. Latham, NASA/ARC	Jet Engine Air Intake System	4,007,891	ARC
Wayne S. Slemp, NASA/LARC	Particulate and Solar Radiation Stable Coating for Spacecraft	4,008,348	LARC
Wayne M. Phillips, Jack F. Mondt, Caltech/JPL Pasadena, Calif.	Nuclear Thermionic Converter	4,008,407	NRLO

Another Dividend from Air and Space

Research and development in aeronautics and space have provided numerous benefits for all Americans—and at a tiny percentage of the tax dollar. Here is an example:

One of the Most Attractive Theater-Concert Halls in the World

The University of Akron's performing arts hall is a cultural and architectural triumph. It was constructed to accommodate concerts, opera, ballet and theater productions. These may be cultural relatives, but they are architectural opposites, because the main hall has to shrink and expand to accommodate audiences as large as 3,000 and as small as 900.

Movable ceilings were required not only to alter the size of the main hall, but also to regulate the volume and manipulate the acoustics.

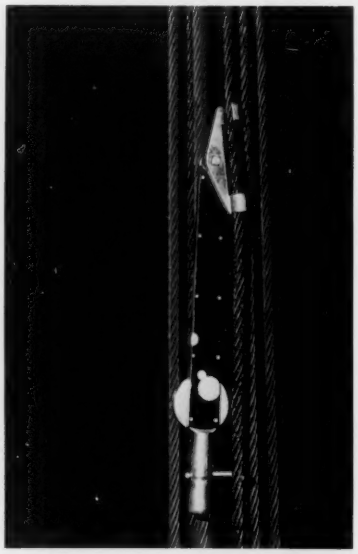
The movable ceiling, the most modern in the U.S., contains overheard hexagons that can be lowered in clusters to exclude either 600 seats or include an additional 1,500 seats.

Once the hall has been sound-tuned, the various positions of this ingenious ceiling and related acoustic curtains may be called into play immediately by pushing buttons on a control console that has been programed previously. With the touch of a finger before an event, a technician may condition the hall for chamber music, symphony, or theater.

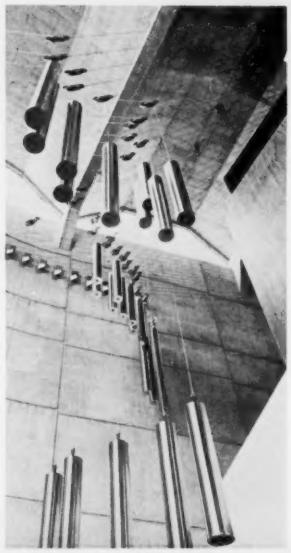
A simple inexpensive tool devised in the space program was used to equalize tensions in the 150 cables of the ceiling. The tool was developed by the Bendix Corp., under contract to NASA's Kennedy Space Center, to adjust the relative tension in elevator and crane cables. The KSC mobile launch tower contains two elevators for lifting spacecraft. The crane in the vehicle assembly building and other hoists at Kennedy also use load-bearing cables.

Previous commercially available cable tools weigh 16 pounds. The Bendix tool weighs only two pounds and costs a tenth as much. Izenour Associates, Inc. of New Haven, Conn., further adapted the NASA tool into a multi-cable version for use in the Akron hall movable ceiling.

In a related, if more prosaic application, the elevator division of Dover Corp of Memphis, Tenn., uses similar NASA-developed cable-tension tools to measure and ajdust the tension on elevator cables in office and other buildings during installation and inspections. The tool saves about 20 percent of adjustment time and increases cable and pulley life.



The tool that makes possible a movable ceiling.



The computer-controlled acoustic ceiling for sound tuning.

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